

CLAIMS

1. An image processing apparatus for removing noise of an input image and for emphasizing contrast of a contour portion,
5 comprising:

a filter for passing a high-frequency component of input image data therethrough;

a deriving section for obtaining first and second conversion coefficients having different magnitude
10 relationships between an image contour portion and noise by subjecting the input image data to discrete wavelet conversion and for obtaining an emphasis control amount based on the square of the first conversion coefficient, the product of the first and second conversion coefficients, and a predetermined
15 setting value;

a multiplying section for outputting the product of the emphasis control amount sent from the deriving section and an output of the filter; and

an adding section for obtaining output image data by
20 adding the product output from the multiplying section and the input image data.

2. An image processing apparatus according to Claim 1,
wherein the deriving section outputs a negative value for an
25 image flat portion to cause the adding section to subtract the high-frequency component from the input image data, and the deriving section outputs a positive value for the image contour portion to cause the adding section to add the high-frequency component to the input image data.

30 3. An image processing apparatus according to Claim 1,

wherein the deriving section comprises:

a discrete wavelet conversion section for obtaining the first and second conversion coefficients by subjecting the input image data to discrete wavelet conversion;

5 a first circuit having a square circuit for squaring the first conversion coefficient;

a second circuit having a multiplier for multiplying the first and second conversion coefficients; and

10 a setting section for calculating and outputting a linear sum of a value obtained by multiplying an output of the first circuit by predetermined α , a value obtained by multiplying an output of the second circuit by predetermined β , and the value of predetermined γ .

15 4. An image processing apparatus according to Claim 3, wherein the setting section causes the emphasis control amount to be a positive value in the image contour portion and to be a negative value in a flat portion by setting $\alpha = -1$, $\beta = 1$, and $\gamma = 0$.

20 5. An image processing apparatus according to Claim 3, wherein the setting section achieves uniform contrast emphasis for all pixels by setting $\alpha = 0$, $\beta = 0$, and $\gamma = 1$.

25 6. An image processing apparatus according to Claim 3, wherein the setting section applies smoothing to all pixels uniformly by setting $\alpha = 0$, $\beta = 0$, and $\gamma = -1$.

30 7. An image processing apparatus according to Claim 3, wherein the setting section achieves image emphasis with noise amplification being suppressed, without removing noise, by setting $\alpha = 0$, $\beta = 1$, and $\gamma = 0$.

8. An image processing apparatus according to Claim 1,
wherein the deriving section comprises a discrete wavelet
conversion section, the discrete wavelet conversion section
5 comprising:

a first high-pass filter for carrying out one-dimensional
filter processing of each line in a horizontal direction of
the input image data to output the first conversion
coefficient in the horizontal direction;

10 a second high-pass filter for carrying out one-dimensional
filter processing of each line in a vertical direction of the
input image data to output the first conversion coefficient in
the vertical direction;

a low-pass filter for carrying out each line in the
15 horizontal direction and for carrying out each line in the
vertical direction of the input image data;

a third high-pass filter for carrying out one-dimensional
filter processing of each line in the horizontal direction of
an output from the low-pass filter to output the second
20 conversion coefficient in the horizontal direction; and

a fourth high-pass filter for carrying out one-dimensional
filter processing of each line in the vertical direction of
the output from the low-pass filter to output the second
conversion coefficient in the vertical direction.

25 9. An image processing apparatus according to Claim 1,
wherein the deriving section further comprises a limiter for
limiting a numerical range of a calculated linear sum.

30 10. An image processing apparatus according to Claim 1,
further comprising an amplifying section for determining a
degree of emphasis by multiplying an output of the multiplying

section by a constant and outputting the product to the adding section.

11. An image processing method of removing noise of an
5 input image and of emphasizing contrast of a contour portion, comprising:

obtaining first and second conversion coefficients having
different magnitude relationships between an image contour
portion and noise by subjecting input image data to discrete
10 wavelet conversion and obtaining an emphasis control amount
based on the square of the first conversion coefficient, the
product of the first and second conversion coefficients, and a
predetermined setting value;

outputting the multiplication value of the emphasis
15 control amount and a high-frequency component of the input
image data; and

causing an adding section to obtain output image data by
adding the multiplication value and the input image data.

20 12. An image processing method according to Claim 11,
comprising calculating and outputting a linear sum of a value
obtained by multiplying the square of the first conversion
coefficient by predetermined α , a value obtained by
multiplying the product of the first and second conversion
25 coefficients by predetermined β , and the value of predetermined
 γ .

13. An image processing method according to Claim 12,
wherein, the emphasis control amount is a positive value in
30 the image contour portion and a negative value in a flat
portion by setting $\alpha = -1$, $\beta = 1$, and $\gamma = 0$.

14. An image processing program for removing noise and emphasizing contrast in a contour portion of an input image, the image processing program causing a computer to make a processing section execute the steps of:

5 reading input image data from a storage section or an input section;

 obtaining first and second conversion coefficients having different magnitude relationships between an image contour portion and noise by subjecting the input image data to
10 discrete wavelet conversion and obtaining an emphasis control amount based on the square of the first conversion coefficient, the product of the first and second conversion coefficients, and a predetermined setting value;

 outputting a multiplication value of the emphasis control
15 amount and a high-frequency component of the input image data;

 causing an adding section to obtain output image data by adding the multiplication value and the input image data; and

 storing the obtained output image data in a storage section and/or outputting the obtained output image data to an
20 output section or to a display section.

15. A computer-readable recording medium having recorded an image processing program for removing noise and emphasizing contrast in a contour portion of an input image, the image
25 processing program causing a computer to make a processing section execute the steps of:

 reading input image data from a storage section or an input section;

 obtaining first and second conversion coefficients having
30 different magnitude relationships between an image contour portion and noise by subjecting the input image data to discrete wavelet conversion and obtaining an emphasis control

amount based on the square of the first conversion coefficient,
the product of the first and second conversion coefficients,
and a predetermined setting value;

outputting a multiplication value of the emphasis control
5 amount and a high-frequency component of the input image data;
causing an adding section to obtain output image data by
adding the multiplication value and the input image data; and
storing the obtained output image data in a storage
section and/or outputting the obtained output image data to an
10 output section or to a display section.